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Recent advances in the determination of a high spatial resolution geopotential model using chronometric geodesy

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Current methods to determine the geopotential are mainly based on indirect approaches using gravimetric, gradiometric and topographic data. Satellite missions (GRACE, GOCE) have contributed significantly to improve the knowledge of the Earth's gravity field with a spatial resolution of about 90 km, but it is not enough to access, for example, to the geoid variation in hilly regions. While airborne and ground-based gravimeters provide the high resolution, the problem of these technics is that the accuracy is hampered by the heterogeneous coverage of gravity data (ground and offshore).

Recent technological advances in atomic clocks are opening new perspectives in the determination of the geopotential. To date, the best of them reach a stability of $1.6\times10^{-1}8$ (NIST, RIKEN + Univ. Tokyo) in just 7 hours of integration, an accuracy of $2.0\times10^{-1}8$ (JILA). Using the relation of the relativistic gravitational redshift, this corresponds to a determination of geopotential differences at the 0.1 m^2/s^2 level (or 1 cm in geoid height).

In this context, the present work aims at evaluating the contribution of optical atomic clocks for the determination of the geopotential at high spatial resolution. To do that, we have studied a test area surrounding the Massif Central in the middle of southern of France. This region, consists in low mountain ranges and plateaus, is interesting because, the gravitational field strength varies greatly from place to place at high resolution due to the relief.

Here, we present the synthetic tests methodology: generation of synthetic gravity and potential data, then estimation of the potential from these data using the least-squares collocation and assessment of the clocks contribution. We shall see how the coverage of the data points (realistic or not) can affect the results, and discuss how to quantify the trade-off between the noise level and the number of data points used.